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EXPERIMENT STATION RESEARCH ON WAR PROBLEMS IN THE HOME

By
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and
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Office of Experiment Stations

WASHINGTON, D. C., SEPTEMBER, 1942

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FOREWORD

This publication deals with the work of the State agricultural experiment stations throughout the fiscal year 1940–41 on problems affecting the home. Although it covers a period ended 6 months before the United States entered the war, much of the work surveyed should be of help in the many adjustments in home living necessitated by the rapid transfer from a peace to a wartime economy.

Heretofore this type of material has been issued as a part of the annual Report on the Agricultural Experiment Stations and made otherwise available in reprint form. Because these reprints are in ever increasing demand, particularly by teachers, extension workers, and leaders of adult education classes, it has seemed advisable to make the information more widely available as a separate Department publication. It is hoped that it may be of service to those concerned with the problems of the home and family in the war for freedom.

James T. Jardine,
Chief, Office of Experiment Stations.

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INTRODUCTION

The year under review was one in which preparedness on the home front was emphasized, with a gradual orientation of all research in the direction of national security and defense. This meant developing certain new projects and modifying old ones to meet anticipated defense or war needs. Much of the work, because of its intensely practical nature, required little or no modification. Certain long-time projects of fundamental nature received recognition and endorsement in the use made of available results by national defense agencies and acquired a new impetus for continuation and expansion. This was particularly true in the field of foods and nutrition. One of the first steps taken by the Committee on Food and Nutrition of the National Research Council, set up in 1940 to advise on nutrition problems in connection with national defense, was to formulate allowances of the important food constituents as tentative standards of requirement for various age groups. These allowances or standards are based upon the results of nutrition research to which the agricultural experiment stations have long contributed. That the standards are considered tentative rather than final is an indication that more research is needed.

The National Nutrition Conference for Defense, held in Washington in May 1941, at the call of President Roosevelt, served to focus the attention of the Nation on the importance of nutrition in defense preparations. At the section on Research and National Nutrition Problems a number of experiment station research workers in nutrition were among the invited speakers, and their reports included some of the recent results of station research in this field. The final recommendations of the conference to the President included the statement:

> it is vital for the United States to make immediate and full use of the newer knowledge of nutrition in the present National Emergency. To neglect this aspect of defense would be as hazardous as to neglect military preparedness.[1]

In addition to emphasizing the importance of making the fullest use of existing knowledge of nutrition through the adoption of the tentative food allowances recommended by the National Research Council and the translation of these allowances and other research recommendations into terms of food selection at different economic levels the conference urged as particularly important:

> vigorous and continuous research to add to our present knowledge of the nutritional needs of individuals, the nutritional status of groups in the population, the nutritive content of everyday foods, and the effects of various methods of production, processing, storing, and cooking on their nutritive value.

The impact of war is also being felt on the home front along other lines than food and nutrition. Priorities in the use of materials already touch upon experiment station research for the home in at least two fields—housing and equipment and textiles and clothing. Rising prices and scarcity in consumer goods of various kinds make studies of family economics and home management of increasing importance. As time goes on and the younger members of the family reach the age of assuming greater responsibility in increasingly difficult situations, factors making for success in personal relationships within the family and in society assume even more importance. These various aspects of preparedness have been kept in mind in the selection of topics for review of the year's progress in research of value to the home.

MINERAL UTILIZATION AND REQUIREMENTS

In working out the recommendations for daily allowances of the dietary essentials, the Committee on Food and Nutrition of the National Research Council encountered some difficulty due to the lack of sufficient experimental evidence on which to estimate requirements of the various nutrients with any great degree of accuracy. Studies at a number of the experiment stations have made rather important contributions to this fundamental knowledge, particularly with regard to requirements for calcium and iron.

Calcium and phosphorus.—A long-continued study by the Illinois station demonstrated that young children of preschool age utilized the calcium in milk or in dicalcium phosphate (a commonly used form of medicinal calcium) equally well, but in neither case was more than 20 percent utilized for body building and regulating purposes. If milk sugar (lactose) was given daily in addition to the regular diet, about 26 percent of the food calcium was retained. These studies were carried further by the Illinois workers, using adult subjects. The findings, confirmed by those obtained by a second group of Illinois workers using different subjects and slightly different methods, showed that adults, like the children, retained only a part of the milk calcium. Some adults utilized only about

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[1] Federal Security Agency. Proceedings of the National Nutrition Conference for Defense, May 26, 27, and 28, 1941. XIII+254 pp. 1942. Washington. D. C.

20 percent, while others utilized between 30 and 40 percent. The amount of calcium required for equilibrium, that is, for the total amount excreted to just balance the total intake, varied with different individuals and depended upon their size. Calculated to a unit-weight basis, the requirement amounted to about 10 to 11 milligrams per kilogram (2.2 pounds) of body weight, suggesting a minimum daily requirement of about 660 milligrams per person. This figure as an estimate of the daily human requirement for calcium is more satisfactory than the long-used 450-milligram estimate which was predicated on the assumption that adults utilize 100 percent of their dietary calcium.

The calcium in taro root, eaten as "poi," a popular Hawaiian dish, was found by the Hawaii station to be well utilized by human subjects eating a diet in which about 80 percent of the calcium was furnished by poi. This study showed also that the phosphorus of the taro was well utilized.

Vitamin D, present in large amounts in certain fish-liver oils or in concentrates prepared from them, is known to help in the body's utilization of calcium and phosphorus for the building and repair of bones and teeth. Sunshine also favors calcification, apparently through acting on certain compounds (sterols) in the skin to convert them to vitamin D. The Arizona station found that the effectiveness of sunlight in Tucson showed seasonal fluctuations, as measured by the ability to cure or prevent rickets in rats on a ration poorly balanced in calcium and phosphorus. The sunshine was most effective from June to October, inclusive, and least effective in January and February. Some protection was afforded at all times, but satisfactory protection was accomplished in the winter months only upon longer exposures. Diurnal variations were also observed in the effectiveness of the sunshine, the greatest protection for a given exposure being obtained at midday (11 a. m. to 1 p. m.). Indirect sunlight or skyshine, as in the shadow of a building, was effective in the prevention of rickets upon increase in exposure times, and showed comparatively little seasonal fluctuation. For complete healing of rickets more solar irradiation was required than for prevention. Although this study was conducted with rats, the generalizations concerning the effectiveness of the sunshine are of significance in relation to the possible occurrence of rickets in children.

Iron.—Since iron occurs in hemoglobin, the red pigment which is the oxygen carrier in the red blood cells, it is generally considered that differences in the level of food-iron intake as influenced by good or bad dietary habits may be reflected in the level of hemoglobin in the blood. At present, however, there are no standards to show what variations in hemoglobin level normally occur due to sex, age, or other factors. As a contribution to such standards the Pennsylvania station has reported hemoglobin values obtained over a 5-year period on 2,400 subjects of different ages from both rural and urban communities in the State, the Minnesota station on over 200 normal high-school girls, and the Hawaii station on nearly 200 preschool children of several racial groups.

Other studies were concerned with the utilization of food iron by human subjects and with the dietary requirement for this element. In controlled studies with preschool children receiving carefully planned diets analyzed for iron content, it was found, by Michigan research workers, that the 5.64 milligrams of iron which was the average daily intake from these diets was apparently ample for the children's needs. On this intake they stored, on an average, about 1.24 milligrams of iron per day (equivalent to 0.07 milligram for every kilogram of body weight). These findings suggest that impractically high levels of iron in children's diets are unwarranted. The daily allowance, 8 milligrams, for this age group as recommended by the National Research Council, is in line with the Michigan data.

A similar suggestion pertaining to girls of college age came from studies conducted at the Nebraska station. In these tests four healthy college girls received for periods of from 3 to 8 months a diet that was adequate except that it furnished only 3.5 to 4.5 milligrams of iron daily. The lower intake (3.5 milligrams daily) was apparently not adequate for their needs, since they lost iron from their body stores to the extent of about 0.33 milligram daily. When the 750 cubic centimeters (a little more than 3 cups) of milk of the basal diet was replaced by 116 grams (about 4 ounces) of lean beef, which furnished an equivalent amount of protein, the iron content of the diet was increased to 6.55 milligrams daily, and there was a large storage averaging 2.14 milligrams. The serum iron decreased consistently and significantly on the low-iron diet, but whenever the iron intake was increased by substitution of beef for milk or by shift to freely chosen diets the levels rose markedly, only to drop again when the low-iron intake was resumed. Hemoglobin values and cell counts remained essentially the same throughout the study, suggesting that these values are not a very sensitive clue to dietary variations in iron over short periods. Although the adequacy of 6.5 milligrams of iron daily for young women in general was not definitely established, the study indicated that the amounts customarily recommended for an adequate diet (12 to 15 milligrams daily) may be unnecessarily high and that adequate utilization of dietary iron may possibly depend upon a liberal supply of other dietary essentials, such as vitamins and protein.

VITAMIN FUNCTIONS AND REQUIREMENTS

Each year the experiment station research on vitamins contributes some results which at the time seem far removed from practical application in human nutrition, while in other work earlier findings in animal experimentation have their final application in human nutrition. In the following review the group of B vitamins and vitamin C have been selected to illustrate a few of the station contributions of the year to knowledge of the vitamins and their function in the nutrition of laboratory animals and of man.

In recent attempts to determine the number of vitamins required by the rat, investigators at the Missouri station were able to use in purified form uncontaminated by other factors no less than four factors belonging to the group of B vitamins—thiamin (vitamin B_1), riboflavin, pantothenic acid (as calcium pantothenate), and choline. Although nicotinic acid, also belonging to the B group, is essential in human nutrition, it was not used in the present experiments because it is apparently not essential to the rat. Other purified vitamins used consisted of a concentrate of vitamins A and D and vitamin E as α-tocopherol. When these seven vitamins were fed in suitable amounts as supplements to a diet of casein as the protein, sucrose as the carbohydrate with a little cellulose for roughage, lard as the fat, and a salt mixture, the rats grew normally and appeared to need no other supplement, although the investigators took the precaution of saying that it was possible that the other ingredients of the diet might conceal some unsuspected vitamin. All of the B vitamins used in the Missouri tests and in addition three other substances sometimes included in the B group—*p*-amino benzoic acid, inositol, and biotin—have been studied by various experiment stations during the year.

Thiamin (vitamin B_1).—The relation of vitamins to the economy of food utilization has been investigated by the Arkansas station through feeding matched pairs of rats a diet complete in every known factor except the one being studied. One of the animals in each pair is given minute amounts of this factor but its food intake is kept the same as that of its pair mate which, because of the lack of an essential factor in the diet, has a tendency to eat less. One of the striking properties of thiamin is its effect on appetite. In the test for this vitamin the rats not getting it soon lost their appetite, ate less and less food, and began to lose weight, while those receiving the thiamin made so much better use of the same quantity of food that they lost only one-third to one-fifth as much weight as the others. Thus, thiamin helps to prevent destruction of body tissues during a period of partial starvation.

The thiamin metabolism of people of various ages is now being studied at a number of the experiment stations. Attempts are being made at the Arizona station to work out a satisfactory nutritional-status test for thiamin. According to preliminary reports, a promising method consists in determining the thiamin content of the urine collected for a 4-hour period following a standard breakfast with which 5 milligrams of thiamin is taken. Excretion of 7 percent or more of this test dose during the period is thought to indicate good nutritional status. Elderly people were selected by the Massachusetts station as the age group most needing study with respect to thiamin because of reports of the beneficial effects of liberal doses of this vitamin in various chronic complaints and disorders of old age. A study of thiamin metabolism and requirements of human subjects has recently been started at the Illinois station as part of an extensive investigation of the assessment of the nutritional status of man.

Riboflavin.—Riboflavin has been found by the Arkansas station to be another important factor in the economy of food utilization. Riboflavin does not have the pronounced effect on appetite characteristic of thiamin. In paired feeding tests similar to those made with thiamin, rats on a riboflavin-deficient diet continued to eat and the food intake of the animals receiving the riboflavin did not have to be reduced. Analyses at the end of the experiment revealed that the gains for the animals receiving the riboflavin as compared with the controls were particularly marked in fat and to a lesser extent in protein. This suggests that riboflavin may have a relation to fat metabolism analogous to that of thiamin in carbohydrate metabolism.

Riboflavin studies of the Wisconsin station have been extended to human beings. In four young women subjects on a fixed diet supplemented by known amounts of riboflavin the excretion of the vitamin decreased or increased with corresponding changes in intake. On the basis of these findings it was concluded that an intake of 1 or 2 milligrams daily is at best no more than barely adequate and perhaps insufficient satisfactorily to supply the daily requirement. The Wisconsin investigators also took part in an investigation at a Birmingham, Ala., hospital of riboflavin excretion, following test doses, by patients in the nutrition clinic suffering from multiple vitamin deficiency. Under these conditions the test was found to have but little diagnostic value. This emphasizes a general principle in the study of any single nutritional factor, namely, that all other known factors should be supplied in sufficient amounts. Another principle which should be kept in mind concerning the vitamins of the B complex and also vitamin C is that since they are not stored to any extent in the body they should be supplied uninterruptedly in the diet.

Pantothenic acid.—It was through studies at the Wisconsin and California stations that the importance of pantothenic acid in the nutrition of the chick was established as recently as 1939. During the past year there have been reports from the California, Alabama, and Wisconsin stations showing that rats deprived of pantothenic acid cease to grow and develop severe bloody necrotic changes in the adrenal glands which, if not too advanced, are cured by the administration of pantothenic acid. Graying of the hair of black rats, first reported from the California station as occurring on diets deficient in some of the B vitamins and being accompanied by signs of adrenal insufficiency, has been found to be due in part at least to deficiency in pantothenic acid.

There is great interest in the antigraying factor or factors because of the possibility of preventing or curing premature graying of the hair and even of postponing certain other signs of aging in human beings. There appears to be a close relationship between riboflavin and pantothenic acid. It was early recognized that young rats deficient in riboflavin look prematurely old. Recent human studies in which one of the California station investigators cooperated have shown that when calcium pantothenate is administered to patients with symptoms of riboflavin deficiency, or even to normal persons, there is an increase in the content of both pantothenic acid and riboflavin in the blood.

***P*-amino benzoic acid.**—This compound has also been found effective in the prevention and cure of graying of the fur in rats, and there have been reports of its successful use as an antigraying factor for humans. In a preliminary note the Arkansas station has announced that *p*-amino benzoic acid is apparently the hitherto unknown factor shown in earlier work to be needed in addition to the known vitamins of the B complex for successful lactation in the rat.

Pyridoxin (vitamin B_6).—In a recent bibliography on this vitamin more than 30 references from eight experiment stations were included. As pyridoxin has been shown to be needed by the rat (work at the Alabama, California, and Wisconsin stations), the chick (California and Wisconsin), and the dog (California), there is reason to believe that it is essential to human nutrition. Some of the effects of a deficiency in pyridoxin are similar to those produced by a diet deficient in certain fats such as lard, and a relationship between pyridoxin and unsaturated fatty acids has been suggested but not as yet definitely proved. Dogs on diets deficient in pyridoxin develop a certain type of anemia. There have been a few reports in the literature of success in the use of pyridoxin in the treatment of certain muscular disorders in human beings.

Choline.—Another substance now classified with the B vitamins is choline. At the Alabama station young rats fed a highly purified diet containing all of the vitamins hitherto known to be essential to rats developed severe symptoms in from 6 to 10 days, while others receiving in addition 20 milligrams of choline chloride daily remained normal and gained weight. Among the symptoms and signs shown by the choline-deficient animals were drowsiness and irritability, greatly enlarged kidneys, and abdominal distention, with death usually occurring in 48 hours after the appearance of the first symptoms. Death was preceded by several minutes of labored breathing, tremors, and coma. Uremic poisoning was shown by blood and urine tests, as well as the subjective symptoms. If the same course of events follows as in the history of the other B vitamins, demonstration of the significance of choline in human nutrition will be the next step.

Biotin.—Reference has been made in earlier reports to the work at the Wisconsin station on egg-white injury in rats. During the past year proof of the significance of this work has come through the demonstration in other laboratories that a newly discovered vitamin of the B group, biotin, is bound by some substance in raw egg white. This substance, which has been named "avidin" because of the avidity with which it unites with biotin, exerts its injurious effect through making the diet biotin-deficient. The Wisconsin investigators are now directing their attention to concentrating the injurious factor, avidin, and have succeeded in obtaining a fraction 100 times as active as the original egg white. In their earlier studies of factors capable of counteracting the effects of egg white, these investigators also accumulated useful information on the distribution of biotin in foods.

It will be noted that of the seven or eight B vitamins discussed, three—thiamin, riboflavin, and nicotinic acid—have been definitely shown to be needed in human nutrition, and there is indirect evidence concerning most of the others. The fact that one of the first steps taken by the Committee on Food and Nutrition of the National Research Council was to promote the enrichment of flour in the B vitamins already known to be essential and which are removed to a greater or lesser extent in ordinary milling processes illustrates the significance of this group of vitamins in human nutrition and the need for increased knowledge of the function of the less well-known members of the group. Pending further work, a number of investigators have pointed out that it may not be safe to give large amounts of any one of the B vitamins which have been made available in the pure form without also giving some food source of the vitamins, because of the danger of upsetting the natural balance of the known vitamins of this group or of not including some hitherto unrecognized factor.

Following the discovery by the Wisconsin station that nicotinic acid prevents or cures the most characteristic signs and symptoms of pellagra, it was demonstrated that the pellagra-producing diet of the South is low in many vitamins other than nicotinic acid and that when nicotinic acid alone is added to the diet other deficiency symptoms develop. The comment by the Wisconsin investigators on this point was that science has not yet come to the point where it can make a good diet out of a very poor one by adding specific vitamins. It is far safer to include in the diet a good proportion of such protective natural foods as milk, meat, fruit, and vegetables, which contain both known and unknown vitamins.

Ascorbic acid (vitamin C).—Studies at the New York (Cornell) station of vitamin C metabolism and requirement of preschool children and of adults, and at a number of stations in the Northwest on college men and women, have been extended, and the accumulated data have been considered in the formulation of standard allowances of this vitamin by the nutrition committee of the National Research Council.

In the Cornell studies a daily ascorbic acid intake of 31 milligrams was found to be about the minimum for tissue saturation of two boys and two girls from 3 years and 7 months to 5 years and 4 months of age. The utilization of the ascorbic acid, which was given in amounts ranging from 17 to 115 milligrams daily, was never higher than 77 percent and averaged 74 percent at the 31-milligram level and only 47 percent at the 50-milligram level. This means that as far as sources of vitamin C are concerned, it is rather wasteful to give excessively large portions, for in amounts considerably above requirements the vitamin C is utilized less economically. In this connection it is of interest that the tentative daily allowance of ascorbic acid adopted by the committee of nutrition (N. R. C.) is 35 milligrams for children 1 to 3 years of age and 50 milligrams for children of 4 to 6 years. Considering the readiness with which vitamin C in ordinary food is destroyed, the actual intake of this vitamin on a 50-milligram allowance would probably be nearer the 31- than the 50-milligram level.

In the extension of the work at the same station on adults, a comparison was made over periods of 2½ to 3 months of the daily urinary excretion of ascorbic acid on different intakes with the blood-plasma values. For these subjects the amount of ascorbic acid required daily for saturation ranged from 90 to 125 milligrams in addition to the amount furnished by the basal diet, approximately 10 milligrams. The blood-plasma ascorbic acid values varied rather widely on the same intake, although with any one subject the highest values were obtained with the highest intakes and vice versa. The mean values for the entire period on intakes sufficient to maintain tissue saturation ranged from 1.07 to 1.58 milligrams percent. The blood levels at which there began to be a marked increase in urinary excretion ranged from 0.9 to 1.6 milligrams percent. It is still a question as to whether or not the daily allowances of ascorbic acid for adults should be those required for saturation. Certainly the requirements can be no higher than those for saturation, as beyond this point the vitamin is not utilized. The recommended daily allowance of ascorbic acid for adults (75 milligrams) is less generous than that for children, as judged by the same standards.

At the five stations in the Northwest—Idaho, Montana, Oregon, Utah, and Washington—where a cooperative project on vitamin C metabolism of college students has been carried on for a number of years, blood-plasma values for ascorbic acid are considered more reliable than urinary excretion values as an indication of dietary habits and nutritional status with respect to vitamin C. As a rough measure of the state of vitamin C nutrition, plasma ascorbic acid values below 0.4 milligram per 100 cubic centimeters were considered to be unsatisfactory, between 0.4 and 0.8 milligram fair, and 0.8 milligram or above satisfactory. In Utah somewhat less than one-fourth of the 127 students examined were in a satisfactory state, and more than three-fourths in a borderline or definitely poor state of vitamin C nutrition. From Montana came the report that among 40 college women students 32 percent had blood values below the level considered borderline, and 15 percent on the borderline. Most of these young women were studying human nutrition but apparently were not putting approved principles into practice. In Oregon 9 out of 24 college women examined were found to be in a good, 10 in a fair, and 5 in a poor state of vitamin C nutrition, while among a much larger number (45) of college men only 2 were in a good, 11 in a fair, and 32 in a poor state of nutrition by the same standard. These findings suggest that either the standards are too high or that there is considerable vitamin C undernutrition among college students in that section of the country. Possibly college life with its activities and nervous strain calls for a more generous intake of vitamin C than is needed by some other groups. The Arizona station found a precipitous drop of from 11 to 20 percent in vitamin C excretion of students following severe, fatiguing exercise and in one subject a 13 percent drop on the day following the nervous strain of an oral examination resulting in a restless night's sleep. With such readily available sources of vitamin C as citrus fruits, tomatoes, fresh raw cabbage, etc., there seems to be little excuse for college students to be deficient in this vitamin.

VITAMINS IN FOODS

The stations have made important contributions to the fund of information on vitamins in foods, and the results of many such studies have been reported. A survey of these reports shows attention to factors causing variation in the vitamin content of raw foods, such as variety, soil, fertilizer, climate, and ration of the animal, and to the effect of processes or conditions such as freezing, canning, storage, and cooking. Increasing attention is also being given to determinations of vitamins in foods as prepared for serving.

A great many of the studies have dealt with ascorbic acid (vitamin C) content. This vitamin has a wide distribution in fruits and vegetables, but is subject to destruction in cooking or processing operations. Its determination, unlike that of other vitamins, may be carried out by a simple, direct chemical method. Among the studies was an extensive one by the Montana station which showed the vitamin C content and cost per serving of many fruits and vegetables, including fresh, frozen, dried, and canned products, as prepared for table use.

There were a few studies on vitamin A or carotene, but most of the other work reported dealt with the various B vitamins—thiamin (B_1), riboflavin (B_2), pyridoxin (B_6), and pantothenic acid. Some of these have been studies to determine the relative distribution of the vitamin in a wide range of foods.

The distribution of pantothenic acid, as determined by biological assay with chicks, was studied by the California station in a wide range of products. Such varied foods as dried brewers' yeast, liver, eggs, broccoli, cane molasses ("blackstrap"), peanut meal, whey, buttermilk, sweetpotatoes, lean beef, skim milk, zucchini squash, and kale were found to be excellent sources (containing more than 28 micrograms per gram of dry material). Canned salmon, potatoes, taro root, alfalfa, wheat bran, canned pumpkin, whole milk, rice bran, split peas, tomatoes, cowpeas, soybean meal, and cottonseed meal were listed as good sources (14 to 28 micrograms per gram of dry material).

Another study was that by the New York (Cornell) station on the distribution of riboflavin in common fruits and vegetables. In the 47 products analyzed, riboflavin, determined by a fluorometric method, varied from 21 to 226 micrograms per 100 grams (fresh basis). The best vegetable sources were green vegetables such as broccoli, spinach, lettuce, Swiss chard, endive, and asparagus. Moderately rich sources were cabbage, Chinese cabbage, celery, tomatoes, squash, apples, and peas, while roots and tubers such as potatoes, sweetpotatoes, beets, carrots, etc., and sweet corn, eggplant, and a few of the fruits were poor sources.

Apples.—Ascorbic acid was determined in a number of varieties of apples by several of the experiment stations (Virginia, New York State, and Washington) analyzing their own locally grown fruits. The values obtained all came within the range of 1.3 to 8.4 milligrams per 100 grams. Storage losses, though varying in different studies (Virginia and Washington), were significant in all tests, and ranged from 25 to 60 percent; much of the loss occurred during the first month of storage. Weight for weight, the peel was found to contain 2.5 to 10 times (depending upon the variety) as much ascorbic acid as the flesh (Virginia). In the same study, cooking was found to cause appreciable destruction of the ascorbic acid, the amount retained in applesauce and in apples baked in pies varying from about 6 to 15 percent of that present in the raw apples, and in fried apples from 11 to 35 percent. Apple juice was found to be a poor source of vitamin C. Freshly pressed samples and a commercially canned unsweetened product analyzed by the New York State and Montana stations, respectively, contained 2 and 3.3 milligrams of ascorbic acid per 100 grams of juice. The freshly pressed samples lost about 50 percent of their ascorbic acid content upon standing at room temperature for 1 or 2 hours or overnight.

These various studies indicate that newly harvested apples may be a fair source of vitamin C. Many varieties eaten to the extent of two a day would furnish from one-sixth to one-third of the recommended 75-milligram daily allowance for adults (N. R. C.). On the other hand, if the apples are stored for a matter of weeks or months, and more especially if they are eaten cooked, they would rate as only a poor source. Apples were found to be a very poor source of pantothenic acid; and riboflavin, in the one sample analyzed, was also very low, amounting to only 73 milligrams per 100 grams.

Blueberries.—Firm, ripe fruits of the Rancocas, Cabot, Pioneer, Rubel, Jersey, and Concord varieties, from bushes grown on adjacent plats (New York State station), and given the same fertilizer treatment, averaged respectively 15, 13, 13, 20, 12, and 18 milligrams of ascorbic acid per 100 grams.

Cherries.—Montmorency cherries were found (New York State station) to contain 9 milligrams of ascorbic acid per 100 grams, while the amount in Napoleon cherries was too low to be measurable. A low content of ascorbic acid was likewise reported by the Montana station, which found from approximately 2 to 6 milligrams per 100 grams in the 4 samples (representing different types) of commercially canned cherries analyzed.

Peaches.—In a varietal study of peaches by the New York State station, the fruits were picked at the firm ripe stage from trees grown on adjacent areas similarly fertilized. The ascorbic acid content varied in the 11 varieties tested from 6 to 14 milligrams per 100 grams. The skins, though constituting but a small portion of the fruit by weight, showed a higher vitamin C content than the pulp, as evidenced by the values of 14 to 41 milligrams of ascorbic acid per 100 grams. Low values were obtained (Montana) for the drained fruit from canned peaches (average 2.4 milligrams per 100 grams), stewed dried peaches (2.1 milligrams per 100 grams), and peaches frozen in sirup (1.6 milligrams per 100 grams). Peach juice prepared by the New York State station contained from 4 to 6 milligrams of ascorbic acid per 100 grams. Peaches are poor sources of riboflavin (New York Cornell) and pantothenic acid (California), as indicated by a single analysis in each case.

Pears.—Washington-grown pears analyzed by the Washington station were found to be a poor source of ascorbic acid, the Comice variety containing but 1.8 milligrams per 100 grams of flesh and the Bosc variety, 2 milligrams. Pears grown in a commercial orchard on the Niagara peninsula in Ontario and picked when the ground color was beginning to turn from green to yellow contained 9 milligrams of ascorbic acid per 100 grams when freshly picked (New York State). During ordinary cold storage at about freezing temperature in open cans, approximately one-third of the ascorbic acid was lost in the first month. At the end of the second month the amount was reduced to 4.9 milligrams per 100 grams, but after this period relatively little loss occurred. In pears stored in closed containers with very small holes in the top so that carbon dioxide of respiration accumulated the loss in 7 months' storage was no greater than in 1 month under ordinary conditions. Canned Bartlett pears, both commercial and home packs, contained but little ascorbic acid—from 0.8 to 2.3 milligrams per 100 grams (Montana). Riboflavin in fresh pears amounted to but 76 micrograms per 100 grams in the single sample analyzed by the New York (Cornell) station.

Raspberries.—Seven varieties of raspberries tested by the New York (Cornell) station gave the following ascorbic acid values in milligrams per 100 grams: Marcy 29, Viking 27, Cuthbert 19, Newburgh 30, Latham 21, Taylor 13, and Lloyd George 13. Raspberry juice pressed from the fruit (Marcy), first heated to 150° F., contained 23 milligrams per 100 grams. Addition of sugar (50 to 65 percent) to the juice caused a reduction to levels of 4 to 13 milligrams per 100 grams. Oxidation by air incorporated while stirring in the sugar is considered the probable cause of destruction of the vitamin. Canned raspberries analyzed by the Montana station contained about 4.5 to 7 milligrams of ascorbic acid per 100 grams, and raspberry jam contained 5.8 milligrams.

Rhubarb.—Several varieties of rhubarb grown at the New York (Cornell) station on the same soil with the same fertilizer treatment and care were analyzed for their content of ascorbic acid shortly after being cut. The stalks of the Victoria, Ruby, and McDonald varieties contained about 6 to 7, and of the Linnaeus variety about 11 milligrams per 100 grams. The ascorbic acid was not uniformly distributed in the stalks, for the skin was somewhat richer in this vitamin than was the rest of the stalk, the top half of which contained twice as much ascorbic acid as did the bottom half, while the top 4 inches contained almost three times as much as the bottom 4 inches. The rhubarb lost no ascorbic acid upon storage overnight in the hydrator of an electric refrigerator but did lose from 8 to 27 percent in cooking; the smaller loss occurred upon stewing for 10 minutes in an open saucepan and the larger loss upon baking for 40 minutes.

Strawberries.—Eleven varieties of strawberries grown in New York and analyzed by the New York State station were found to be an excellent source of ascorbic acid, containing from 40 to 104 milligrams per 100 grams. Values (in milligrams per 100 grams) reported by varieties are as follows: Bliss 40, Camden 54, Dorsett 59, Culver 60, Bouquet 63, Chesapeake 63, Fairfax 68, Clermont 73, Redheart 84, Southland 93, and Beacon 104. A commercial pack of frozen strawberries (with sugar) analyzed in a Montana study contained 31.4 milligrams of ascorbic acid per 100 grams, and preserves and jams from 18.8 to 23.6 milligrams.

Asparagus.—The commercial freezing of asparagus did not appreciably lessen its carotene (provitamin A) content, as was shown in a cooperative study by the New York (Cornell) and State stations, nor were there very large losses of thiamin and riboflavin (about 22 and 5 percent) as determined in tests by the Massachusetts station. The losses of the B vitamins sustained in commercial freezing, as well as in canning, varied with the length of the blanching period. Long storage (6 months) of frozen asparagus resulted in a definite loss of vitamin C (New York State station). From these various studies and from vitamin C determinations by the New York (Cornell) and Montana stations and pantothenic acid assays by the California station, the following figures are gleaned for the vitamin content per 100 grams of the various samples of fresh asparagus analyzed: Carotene 700 micrograms, thiamin 195, riboflavin 160 micrograms, ascorbic acid 35 to 45 milligrams, and pantothenic acid about 6 micrograms. For frozen samples the values were carotene 640 micrograms, thiamin 153, and riboflavin 150 micrograms. In the canned product the values reported for the solid portion were thiamin 69 micrograms, riboflavin 100 micrograms, and ascorbic acid 25 milligrams. The liquor of the canned products also contained some of each of these vitamins due to their solubility in water.

Beans.—Snap beans were reported as containing from 70 to 100 micrograms of thiamin (Oregon station) and 93 to 101 micrograms of riboflavin (New York (Cornell)) per 100 grams of the fresh beans. Ascorbic acid in frozen green beans heated for serving and in canned beans (reheated) amounted, respectively, to 5.5 and about 3 to 5 milligrams per 100 grams (Montana). There was no appreciable loss of ascorbic acid in frozen green and wax beans stored for 6 to 10 months at temperatures from −40° to −9° C. (New York State station).

The effect of cooking on the thiamin content of dry beans was investigated by the Michigan station. Dry Michelite and Cranberry beans, assayed by the rat growth method, contained 170 and 90 International Units per 100 grams in the raw state. The availability of the vitamin was increased by cooking, however, since the boiled or baked beans assayed from about 200 to 300 International Units per 100 grams. Beans boiled in the water in which they were soaked contained no more of the vitamin than soaked beans boiled in freshly changed water. Soda used in the soaking water but thoroughly rinsed off before cooking shortened the boiling time by from 5 to 15 minutes, but caused no destruction of the vitamin. Baked beans contained slightly less thiamin than boiled beans.

Freshly harvested green lima beans (Henderson Bush), containing 240 micrograms of carotene per gram, were found by the New York (Cornell) and State stations to retain most of their carotene upon quick-freezing, and the carotene content of the frozen beans did not change during 5 months of storage of the frozen beans at 0° or −40° F. The influence of quick-freezing on the thiamin and riboflavin content was investigated by the Massachusetts station. Henderson Bush lima beans contained 201 micrograms of thiamin per 100 grams before quick-freezing and 93 micrograms after freezing, a loss of 54 percent. Riboflavin dropped from 365 to 300 micrograms, a loss of 18 percent. In the canning process, also studied by the Massachusetts station, there was a 72-percent loss of the thiamin and a 30-percent loss of the riboflavin.

Ascorbic acid in frozen lima beans, prepared by blanching and freezing without delay, ranged from 16 to 29 and averaged 22.5 milligrams per 100 grams, in the 12 varieties and strains analyzed by the Utah station. For the same variety the ascorbic acid values for green lima beans were higher than for white ones and small beans showed higher values per unit weight than did large beans. The cooking of quick-frozen lima beans was found by the New York (Cornell) and State stations to cause a destruction of their ascorbic acid content amounting to less than 15 percent except when the beans were cooked in a pressure cooker, in which case 36 percent of the vitamin was destroyed. The ascorbic acid in the cooking water amounted to 31 percent of that originally present in the frozen beans (20 milligrams per 100 grams) when these were boiled in a covered aluminum saucepan, but to only 11 percent when the cooking was done in a pressure saucepan. The drained beans of a single sample of canned lima beans contained 12.3 milligrams of ascorbic acid per 100 grams (Montana station).

Brussels sprouts.—Commercial packs of quick-frozen brussels sprouts held in storage at −18° C. for 6 months showed a definite loss of vitamin C, according to observations by the New York State station. Quick-frozen brussels sprouts used in the New York ((Cornell) and State stations) study of cooking losses contained 63 milligrams of ascorbic acid per 100 grams of the vegetable. Destruction of the vitamin in the cooking process was not more than 9 percent in any of the tests. Fourteen percent of the vitamin originally present was leached into the cooking water when the brussels sprouts were boiled, 5 to 8 percent when they were steamed, and about 8 percent when they were cooked in a pressure saucepan. Fresh cooked brussels sprouts analyzed by the Montana station contained about 95 milligrams of ascorbic acid per 100 grams of the cooked vegetable.

Cauliflower.—Studies similar to those on broccoli were made by the stations just noted. The quick-frozen cauliflower contained 63 milligrams of ascorbic acid per 100 grams, and lost not more than 10 percent of the vitamin by destruction in cooking. Twenty-three percent of the vitamin was leached into the cooking water upon cooking in a covered saucepan, 13 to 19 percent by steaming, and only 8 percent by cooking in a pressure saucepan. The single figure reported by the Montana station indicated an ascorbic acid content of 42.2 milligrams for every 100 grams of the cooked vegetable.

Eggplant.—The Black Beauty variety of this vegetable, analyzed by a method developed at the New York State station for accurately determining the ascorbic acid content of pigmented fruits, was found to average about 5 milligrams of ascorbic acid for each 100 grams of the entire fruit. The ascorbic acid content in the skin was about 7 milligrams per 100 grams, with little difference between the portion immediately under the skin and the center portion. There was but little loss of ascorbic acid on storage for 5 to 19 days at room or freezing temperatures. Eggplant was among the vegetables found by the New York (Cornell) station to contain very little riboflavin, in the case of the sample analyzed only 31 micrograms per 100 grams.

Parsnips.—Cooking tests by the New York (Cornell) station showed that parsnips retained as much as 95 percent of the ascorbic acid in the raw vegetable (15–30 milligrams per 100 grams) when boiled whole and unpeeled, but only 81 percent if peeled and cut in pieces for boiling; cooked in a pressure saucepan they retained 90 percent of the vitamin if cooked just to doneness but only 78 percent if overdone by as much as 5 minutes. The parsnips used in these tests were of the Hollow Crown variety and had been stored in a cold-storage room at 34° to 35° F. and a humidity of 95 to 100 percent until November, December, and January.

Peas.—Fresh peas of the Thomas Laxton variety containing 399 micrograms of thiamin and 210 micrograms of riboflavin per 100 grams were found, in tests by the Massachusetts station, to retain about 60 percent of their thiamin and 100 percent of their riboflavin when canned and 97 and 100 percent of these two vitamins, respectively, upon quick-freezing. These values, together with those for quick-frozen peas of the Alderman and Stratagem varieties, analyzed by the Oregon station, showed a range in thiamin from 280 to 820 micrograms per 100 grams of the frozen sample. Variations in thiamin content appeared to depend not only upon variety but upon such factors as climate, soil, maturity, and slight variations in processing (Oregon station). A study of cooking losses (New York State station) showed that quick-frozen peas (containing 21 milligrams of ascorbic acid per 100 grams) retained about 70 percent of this vitamin when boiled.

About 18 percent was lost into the cooking water, and some of the vitamin was apparently destroyed in the cooking process. With steaming about 68 percent of the vitamin was retained and 18 percent leached out, while cooking in a pressure saucepan resulted in the greatest retention—about 88 percent. Cooked frozen-pack green peas analyzed by the Montana station contained 8.8 milligrams of ascorbic acid per 100 grams, and two samples of canned peas (reheated) contained 12 and 18 milligrams.

Potatoes.—The Hawaii station found that Hawaiian-grown potatoes gave unusually high values for ascorbic acid, 100 grams of the raw potato containing 27 milligrams as compared with 13 milligrams in a single sample of California new potatoes analyzed for comparison. The Hawaiian potatoes after cooking contained 29 milligrams of the vitamin (per 100 grams) if baked and 22 milligrams if boiled in the skin. These values are much higher than the 10.5 and 8.6 milligrams reported by the Montana station for boiled samples of Bliss Triumph and Netted Gem potatoes that had been stored. About 44 to 55 micrograms of riboflavin and about 650 micrograms of pantothenic acid per 100 grams are the values reported for potatoes by the New York (Cornell) and California stations, respectively.

Spinach.—Raw quick-frozen spinach used in the study by the New York State and (Cornell) stations contained 32 milligrams of ascorbic acid per 100 grams. From 70 to 80 percent of this was retained when the frozen spinach was cooked, the lowest retention occurring with boiling and the highest with cooking in a pressure saucepan. Strained spinach, packed in glass containers at a cannery and sealed by a vacuum method, was found to retain about 85 percent of its vitamin A and 75 percent of its ascorbic acid after a year's storage in subdued light.

Tomatoes.—The ascorbic acid content of different varieties of tomatoes which were adapted to early season, midseason, and late season use was determined over three seasons by the Utah station analyzing Utah-grown tomatoes from five experimental plats. The average value for all these samples, analyzed shortly after picking, was about 26 milligrams per 100 grams; and for 18 varieties analyzed in one season not considered favorable for first-class tomatoes because of heat and later heavy rain, about 21 milligrams per 100 grams (range 19 to 25 milligrams). Tomatoes from pole-supported vines gave significantly higher values than those from adjacent vines not supported, but greenhouse tomatoes were only about one-half as rich in ascorbic acid as the same variety grown on an outdoor plat near the greenhouse. Tomatoes held as long as 18 days, either at laboratory temperature or in the refrigerator at 44° F., showed no loss of ascorbic acid.

Studies to determine why tomatoes in glass jars lost ascorbic acid were carried out by the Wisconsin station, but did not yield conclusive results. Improving the seal by painting over the rubber ring and the adjacent glass with paraffin or storing the untreated jars in an atmosphere of carbon dioxide did not help, since tomatoes stored under these conditions for 5 months contained no more ascorbic acid than those canned without any extra precautions. Pouring paraffin into the jar at canning time so as to leave no air space about the fruit likewise produced no noticeable improvement. About 15 percent of the vitamin A in bottled tomato juice was lost after storage in subdued light for about a year; in amber glass the loss was somewhat less (Massachusetts station). At a storage temperature of 36° F. less than 5 percent of the ascorbic acid was lost within the year, while at 90° the average loss approximated 21 percent. Storage in the light hastened the loss but did not affect the total loss. Commercial tomato juice analyzed by the Montana station was found to contain 14 milligrams of ascorbic acid per 100 grams, and canned tomatoes 20 to 22 milligrams. Pantothenic acid and riboflavin in tomatoes averaged 100 micrograms and 50 micrograms per 100 grams in the samples analyzed by the California and New York (Cornell) stations, respectively.

Cereals and cereal products.—The few studies reported within the year were concerned with wheat or wheat germ. Long cooking of wheat cereals did not in general cause appreciable destruction of the thiamin (Michigan station). Wheat germ (assaying 1,970 micrograms of thiamin per 100 grams) incorporated in muffins lost practically none of its thiamin value if no baking powder was used; about 26 percent of the thiamin was destroyed, however, if the muffins were made with baking powder (Oregon station). One sample of wheat germ assayed by the Wisconsin station contained 1,590 micrograms of pyridoxin per 100 grams.

Eggs.—The effect of the hen's feed on the pantothenic acid content of eggs was demonstrated at the Texas station, where eggs from White Leghorn hens maintained from hatching on a diet deficient in pantothenic acid contained on an average 41 and 966 micrograms of pantothenic acid per 100 grams of white and yolk, respectively, as compared with averages of 76 and 4,680 micrograms per 100 grams for whites and yolks of eggs from hens on a stock diet. Whole eggs (without shell) averaged 361 and 1,732 migrograms per 100 grams for these two groups, respectively. With sufficient addition of pantothenic acid to the deficient ration, the content of the vitamin in the eggs could be increased up to about twice that in eggs from hens on the stock diet.

Meat.—The distribution of pyridoxin in meat and meat organs was determined by the Wisconsin station, using a bio-assay method. Kidney and muscle, containing from 300 to 700 micrograms of the vitamin per 100 grams, were the richest sources, while heart and liver were somewhat lower, with from 250 to 350 micrograms; spleen, pancreas, brain, and lung were poor sources. Of the cooked meats, the fried samples showed least destruction of the pyridoxin, while roasting and stewing caused losses of from 20 to 50 percent. Commercial processing (drying and tenderizing) resulted in similar losses. Fish muscle, like beef, lamb, pork, and veal, was rich in the vitamin, but dark chicken muscle was a poor source.

Chicken.—Studies at the New York (Cornell) station showed that the amount of riboflavin in the diet of the chicken influenced the amount of this vitamin stored by the various tissues. Analyses by a fluorometric method of the fresh tissues of chickens fed low- and high-riboflavin diets, respectively, gave values of 1,120 and 3,290 micrograms per 100 grams of liver, 430 and 1,840 micrograms for heart, 130 and 410 micrograms for gizzard, 100 and 420 micrograms for leg (dark meat), and 40 and 80 micrograms for breast (light meat). Leg and breast tissues from five birds fed a commercial diet averaged, respectively, 930 and 360 micrograms per 100 grams. Another study by the same station indicated that cooking, whether frying, broiling, roasting, or stewing, does not cause any measurable destruction of the riboflavin in chicken meat.

Pork.—Work at the California station in cooperation with the Department (B.A.I.) indicated that the thiamin content of the muscle of the pig is related to the amount fed to the animal. Thus ham muscle, assayed by a biological method, contained 140, 440, and 480 micrograms of thiamin per 100 grams following daily thiamin intakes of 1, 4, and 6 milligrams per 100 pounds of pig. The riboflavin content of the pork muscle likewise varied with the amount of the vitamin fed, at least up to a certain level of dietary intake (3 to 6 milligrams per 100 pounds of pig daily). On low-flavin diets the pig muscle contained from 130 to 170 micrograms of riboflavin per 100 grams (fresh basis), while on the higher dietary levels the muscle content ranged from 210 to 330 micrograms.

FOOD SELECTION, PREPARATION, AND UTILIZATION

To maintain quality standards for food is particularly essential at a time when every effort is being made to improve the nutritional status of the Nation through better diets. The selection of foods of the best quality as well as highest nutritive value, the use of methods of preparation which will best bring out and enhance inherent quality, more widespread introduction of little-known or -used foods of high nutritive value, and the substitution of less expensive for more expensive foods of the same type are problems to which the experiment stations continue to devote much attention.

Potatoes.—Much time and thought have been spent in attempts to determine satisfactory methods of judging quality in potatoes. Mealiness is the quality most desired for steamed, boiled, or baked potatoes. After testing over 2,000 potatoes grown under known cultural conditions, investigators at the New York (Cornell) station found that the simple specific-gravity test on the raw tubers, as recommended by the New Hampshire station, gave results consistent with those obtained with more elaborate tests and with personal-opinion ratings on the steamed potatoes. The samples graded as soggy, slightly soggy, slightly mealy, and mealy had average specific gravities of 1.066, 1.078, 1.085, and 1.092, respectively, and showed consistent differences in the other tests. On the basis of extensive quality studies the Colorado station has concluded that for general all-around use, potatoes with relatively high specific gravity will most nearly meet all requirements, and has suggested the sorting or grading of potatoes by means of specific gravity as a practical method of throwing varieties or potatoes within a variety into quality grades. Another simple test has been devised at the Massachusetts station for distinguishing mealy from waxy potatoes. When slices of freshly baked potatoes are dried, the tissues of mealy potatoes become white and very porous while those from waxy potatoes shrink to a dense glassy mass, light tan in color.

Varietal tests have been reported from a number of the stations. It has been emphasized by the Colorado station that potatoes are grown for both general and specialized uses, and that no potato variety is entirely satisfactory for all purposes. Among several varieties tested at the Maine and New York (Cornell) stations, the Green

Mountain ranked highest, the Katahdin intermediate, and the Chippewa and Earline lowest for mealiness. That a single variety may be very mealy when grown in one region and not mealy in another was shown by cooking tests at the Maine station on samples of Chippewa grown in 13 States. When classified in four grades of mealiness from 1 (nonmealy) to 4 (very mealy) the samples from three States fell in grade 1, six in 2, five in 3, and two in grade 4. At the Minnesota station the Russet Burbank (grown in sandy loam soil) was given the highest rating of the important commercial varieties for all methods of cooking. Among 4 varieties cooked in different ways at the New York (Cornell) station the Chippewa and the Cobbler were recommended for steaming and boiling and the Rural for baking. A given lot of New York State Smooth Rural potatoes was found to be mealy when baked, slightly mealy when steamed, pared or unpared, or boiled unpared, and slightly soggy when boiled unpared. Any process that resulted in the absorption of considerable water before or during cooking decreased the mealiness of the cooked potato.

Soybeans.—For some years a number of the experiment stations have been interested in promoting a greater use of soybeans as a food, not only in the mature state but also as the young "green" or vegetable-type beans. The efforts of the Department (B.P.I.) and the Illinois station in distributing suitable varieties of seed throughout the country have led to a widespread interest in the vegetable-type soybean as a promising new vegetable. There has already been a marked increase in the home production of soybeans of this type, and in several States, notably Wisconsin, increasing amounts are being canned commercially.

The superiority of soybeans over cowpeas in many respects has been shown by the Alabama station in a series of comparisons. While varietal differences in the quality of the proteins were evident in both soybeans and cowpeas, two common varieties of the latter (Cream Crowder and California Blackeye) were found to have protein of too low biological value to support life in laboratory rats when no other source of protein was fed. As dietary surveys have shown that the Alabama farm population is on a low level of protein intake and that about one-half of the protein comes from corn and wheat flour of inferior biological value, a shift from the more commonly used cowpeas to soybeans (both as green vegetables and mature) is urged by the station as a means of dietary improvement.

A demonstration of the practicability of substituting home-grown soybeans in part for meat and other high-protein foods is being carried on in the Crossville subsistence homestead project of the Tennessee station. During 1937 to 1939, inclusive, soybeans were tested in numerous combinations with other foods by six of the families in the community. A laboratory was set up to test various methods of preparing the beans, and demonstrations were given of the methods found satisfactory and practical for the community. A station circular was published giving tested recipes for the use of soybean meal in breads, biscuits, rolls, and muffins; for boiling the mature beans in the pressure cooker or open kettle; and for making salted soybeans. For this product, earlier suggestions by the Wisconsin station of soaking the beans before deep-fat frying to improve the value of the protein on heating were followed. In the opinion of those in charge of the Crossville project the large percentage of the rural population of Tennessee known to be living on low-acreage units would profit by the home production and use of soybeans.

Milk.—One means of increasing milk consumption, particularly in localities where it is difficult to obtain fresh milk, is to make more use of dried milk, either whole or skim. In the food preparation laboratories of Kansas State College a comparison was made of fresh skim milk, dry skim milk in equivalent quantities, dry skim milk in double these quantities (for the purpose of increasing the nutritive value of the product), and dry whole milk in the preparation, according to institutional recipes, of a number of foods. All of the products were judged acceptable, with no marked differences in scoring for the same product prepared with the different forms of milk tested. Dry skim milk, however, scored highest in biscuits, medium white sauce, butterscotch pudding, and white cake; dry skim milk, doubled in amount, in cocoa and asparagus soup; and dry whole milk in muffins, cheese souffle, macaroni and cheese, and cream of tomato soup. Cost calculations on the basis of 50- and 100-pound lots of the dried products and 10 gallons and less than 10-gallon lots for the liquids showed dry skim milk to be the least expensive form used, when calculated in terms of volume equivalents, followed in order by fresh skim milk, dry whole milk, and fresh whole milk. From these findings it is evident that the use of dry skim milk and dry whole milk is an economical and satisfactory means of supplying milk in large-scale feeding, such as the school lunch, as well as a practical means of increasing milk consumption under certain circumstances.

A special study by the Minnesota station of the use of dry milk in sponge cake showed that the milk could be used in amounts up to half the weight of the flour, although smaller proportions, 15 to 30 percent, gave somewhat better results. For each 15 percent of dry milk solids, increasing the water in the recipes by 10 percent is advised. The dry milk should be first mixed with the sugar and the mixture prewarmed to 95° to 100° F. before beating with the eggs at medium beating speeds. Egg yolks gave better and egg whites poorer cakes than whole eggs. The cakes made with the dry milk staled less rapidly than milk-free cakes.

Eggs.—Another dried food product that can be used in many ways in place of the fresh product is egg white. A comparison was made at the University of California of the cooking performance of fresh egg white, laboratory-dried egg white prepared from the fresh by drying on porcelain plates at 45° C. (113° F.) in a vacuum oven, fermented flake albumin, and a commercial dried egg white prepared by acid treatment followed by spray drying. Used in meringues where expansion and coagulation of the protein were of minor importance, the commercial samples were found to whip better, with greater volume and less drainage, than the fresh white or vacuum-dried white. In all batter and dough products, however, the commercial products were greatly inferior. Popovers failed to pop; cream-puff shells were smaller, poorly browned, and heavy walled; and angel-food and whole-egg sponge cakes smaller in volume and of heavier compact texture than when made with the fresh or vacuum-dried egg white.

Egg quality studies at the Colorado station, incidental to the long-time altitude cookery research program with particular reference to cakes, have shown that eggs of individual hens differ significantly in quality for cake making and that the higher-quality eggs also deteriorate more slowly than the average in storage. This discovery is considered by the station to be of considerable economic importance, since approximately half of the initial quality of many of the eggs now on the market is lost before the eggs reach the consumer. Of help to the housewife who has to use these deteriorated eggs is the announcement by the Colorado investigators that it is possible to correct at least in part in cake baking for inferior quality in the eggs used, for in many respects decrease in egg quality is similar in effect to that of increase in altitude and can be corrected in a similar manner. Pullet eggs were found by the station to be of very high quality, and it has been suggested that these might well be frozen and handled separately by the industry.

FOOD PRESERVATION

The additional feeding load to meet the food needs not only of our own country but also in part those of Great Britain and eventually other countries, will be met not alone by increased food production but by increased preservation of foods as well. Likewise, increases in home production of foods for home or local use will necessitate an increase in the amount of food preserved, for only by preservation can seasonal surpluses of perishable foods be carried over into leaner times and periods of nonproduction. Several of the experiment stations have reported results of studies having direct bearing on preservation by freezing and canning.

Freezing and frozen storage.—The use of freezing and of locker facilities throughout the country has become a very popular method among farm families for preserving and holding home-grown products over considerable periods of time. Of the foods preserved in most lockers and home freezing cabinets meats and poultry comprise a large proportion—from 60 to 75 percent according to some estimates, and even from 90 to 95 percent as observed in a 1939 survey in Wisconsin. The large volume of frozen-meat storage and the numerous problems connected with it have led to studies by a number of the stations.

In freezing beef at different low temperatures (0° to $-25°$ F.) in still air, in an air blast, and in brine the New York (Cornell) and State stations found that the use of a fan cut in half the time required for freezing, and that even this time was halved in brine-immersion freezing. Rapid freezing at the low temperatures caused little break-down of the tissues, so that the quick-frozen meats resembled fresh meat. The more rapidly the meat was frozen the better its all-around quality, although even the slowest-frozen roast was tender, juicy, and of good flavor. Storage temperatures above 0° F. were found unsatisfactory for meat, since the fat of the samples became somewhat rancid in 3 to 5 months. At 0° or lower, however, the samples were still in good condition at the end of 14 months.

A preliminary report by the Washington station indicated that wrapped frozen beefsteaks held in frozen storage for 4½ to 8½ months showed no difference with regard to tenderness, juiciness, and flavor of the lean, although the flavor of the fat scored lower as the storage period lengthened. The steaks were of good quality after 8½ months of storage. Work at the Indiana station likewise showed that quick-frozen beef may be satisfactorily kept in frozen storage for long periods. Samples kept as long as 12 months remained palatable, although the fat in some cases was judged less desirable, even if not inedible.

In a study of the effect of freezing and storage on pork, the Indiana station found no differences in the keeping quality of meat from hogs fed hardening or softening feeds. Palatability and tenderness tests on a large number of quick-frozen pork-loin roasts and chops held in storage from 4 to 16 months and tested after cooking showed that the freezing had no marked effect on the tenderness or the cooking losses of these cuts. The pork kept satisfactorily in frozen storage except that the desirability of the flavor of the fat decreased somewhat with storage periods longer than 8 months. These results confirmed those obtained earlier by the Michigan and Minnesota stations. The latter station, continuing the tests on pork-loin roasts stored at 0°, 10°, or 15° F., removed them from frozen storage at 3-week intervals up to 33 weeks. These roasts were cooked and judged by experienced judges whose scores showed that sufficient change to be readily detectable by a critical person probably must be expected in important quality factors in even the best of pork roasts during 18 weeks' storage at 0° or above.

Based on such experimental studies as these and on established trade practices, suggestions for the preparation and handling of meats in frozen storage were issued by two stations. The New York State station pointed out that while the freezing of meat makes it more tender, it does not make a choice product out of poor, tough material, so that young animals or birds really furnish the best frozen products. The aging of carcasses prior to cutting and freezing is generally considered to improve the tenderness of the meat, but preliminary work at the station indicates that the longer meat is aged the sooner it becomes rancid in freezing storage, and that poultry, pork, lamb, and veal should be hung no longer than the time it takes for the carcass to cool thoroughly (1 to 2 days). Packaging is also very important, since unwrapped or poorly wrapped meats dry out in storage, lose their fresh flavor, and even absorb undesirable foreign flavors. Moisture-vapor-proof papers or cellophanes are noted as among the most satisfactory wrapping materials for both meat and poultry. In storage, the packages (which should weigh no more than 5 to 7 pounds) should be so arranged that there is free movement of air around them, and the temperature should be kept no higher than 0° F.

Many of these points were also stressed in the general directions issued by the Michigan station for preservation of meats and poultry in frozen-food lockers. In addition attention was called to the necessity of strict cleanliness in all operations involved, since freezing does not sterilize meat but merely slows up the activity of bacteria, molds, and enzymes normally present. The meat, therefore, is only as clean as the method and utensils used in slaughtering, cutting, and wrapping.

The freezing of fruits and vegetables is practiced in many areas as a means of conserving the home-grown crop for family use. The Georgia station suggested that the operation of a commercial freezing plant in a region capable of supporting it would serve as an outlet for fruits and vegetables, and animal products as well, that could be raised as cash crops. Directions for laying out a freezer-locker plant as well as a commercial freezing plant, together with cost figures and suggestions for operation, was published in a recent station bulletin. General information concerning such points as the suitability for freezing, the form in which frozen, treatment before freezing, suitable varieties, wrapping materials or containers, season of operation, weight losses in processing, and uses of the frozen products was also given. Similar information concerning methods and suitable varieties was issued by the Colorado station, which also cautioned that all frozen vegetables, since they are not sterile, should never be tasted or eaten until thoroughly cooked, should be cooked promptly after thawing, and should not be refrozen once thawed.

The results of trials to determine the desirability for freezing of different varieties of vegetables suitable from the standpoint of yield under North Dakota growing conditions were reported by the North Dakota station in continuance of work begun in a previous season; and the New York State station made a study of varieties of fruits adaptable to culture in New York and suitable for freezing. The latter station, working on the problem of preparing and freezing certain vegetables in lockers, found that the period required for blanching any given vegetable in live steam was approximately 50 percent greater than that needed for scalding in boiling water. It was noted that the quality of all the frozen products, both steam- and water-blanched and dry- and brine-packed, was very good except for kale and New Zealand spinach, neither of which gave desirable products. Brine-packed vegetables did not dry out in storage and were of good flavor, but the brine added weight and necessitated the use of watertight containers.

A method developed by the Illinois station for preservation of vegetable soybeans by quick-freezing yielded a satisfactory product showing excellent retention of natural color, texture, and flavor.

Canning.—Home canning offers excellent opportunity for conserving surpluses of garden vegetables and farm-produced food. Certain canning problems have been considered in the research program of three of the experiment stations. The Wyoming station, aware of the fact that spoilage most commonly occurs in nonacid home-canned vegetables at high altitudes and that most of the outbreaks of botulism have occurred in the high-altitude districts of the United States, associated these facts with faulty canning processes. Steam pressure-cooker processing, recommended as the only safe method of canning nonacid vegetables, presents at high altitudes problems not encountered at lower altitudes since the elevation affects the reading of the pressure gage, thus necessitating modifications in time or pressure. Moreover, gages may become defective. The station developed, therefore, accurate methods of testing the gages of pressure cookers at different altitudes and applied these methods to practical testing of about 200 gages from pressure cookers in actual use in homes or canning centers. Readings of about 20 percent of these gages deviated by 3 to 5 pounds from the actual pressure, and for most of the remainder the deviation was 1 to 3 pounds, with only one deviating less than 1 pound. From questionnaires answered by the homemakers, it was evident that spoilage, particularly with nonacid vegetables such as beans, squash, corn, and peas, was largely associated with inaccurate gages. This study was of considerable practical value to homemakers, who were made aware of the dangers of improper processing of such foods and led to replace defective gages or other defective parts of cookers with new ones.

Certain varieties of vegetable soybeans canned at the Alabama station yielded very satisfactory products with greater retention of their carotene contents than occurs in beans allowed to ripen and stored dry. In canning tests conducted at the Iowa station on two varieties of vegetable soybeans at two stages of maturity and with and without added salt, acid (vinegar or lemon juice), and sugar, the addition of acid was found to give a distinctly less desirable product, and of sugar and salt a more desirable product than canning the beans with no additions. The highest ranking products were those to which 1 teaspoonful each of salt and sugar per No. 2 can had been added. Processing at 10-pounds pressure for 30 minutes was sufficient for the plain beans, while those with added acid scored highest with a processing period of 40 minutes.

FOOD CONSUMPTION AND NUTRITIONAL STATUS

The adequacy of a diet is customarily evaluated in one of two ways: By comparing the food consumption of the individual or group being studied with present standards of adequacy, or by judging the nutritional status of each person receiving the diet. A third and ideal method combines these two and furnishes still more definite proof of the inadequacies thus determined by supplementing the customary diet with food furnishing more of the dietary factors considered lacking and after a period redetermining the nutritional status. Until quite recently experiment station research on dietary habits consisted almost entirely in studies by the first method. Now there is a growing tendency to adopt the newer methods of evaluating nutritional status with or without accompanying dietary records.

Food consumption and adequacy of diets.—The South Carolina station has been making a systematic study over a period of years of the food consumption of white and Negro families of varying incomes in different sections of the State. Over 1,000 weekly records of family food consumption have now been analyzed and classified as good, fair, and poor, according to present standards. The food records of the 669 white families have been further classified by money cost of the diets into two groups at a dividing point of a weekly per-capita cost of $1.90, the two groups being of about the same size. As would be expected, the proportion of good diets was much higher in the higher food-cost group and of poor diets in the lower cost group, but there were some poor diets in the higher and some good diets in the lower food-cost group. Only 11 percent of the Negro diets had a per capita money value of as much as $1.90 per week. About 50 percent of the diets were rated as poor and only 10 percent as good.

In another study by the South Carolina station, a survey was made of the year's food supply of 136 rural white families in one county of the State. At its best the food supply was good in quality and quantity, but at its worst was inadequate for growing children because of insufficient supplies of milk products, eggs, lean meats, vegetables, and fruits. The provision of enough vegetables for family use throughout the year appeared to be one of the most difficult problems. Many plantings of garden vegetables failed because of unfavorable weather, lack of proper timing of planting and cultivation, failure to control blight and insect pests, and use of poor seed. Even the winter turnip patch was not always a success. Frequently the sweetpotatoes raised on the farm were lost through freezing or other spoilage, and there was considerable spoilage of canned tomatoes, beans, and other vegetables. In the selection of foods to be preserved in various ways little knowledge of relative nutritional values was evident.

A study by the Mississippi station of foods produced and consumed during 1938–39 by young farm families (including owners, share renters, and share croppers) in a poor agricultural area of the State as compared with the recommendations of the State extension service based upon the standards set up by the Department (B.H.E.) showed that the goals were far from being reached. The owner families produced the most food for home consumption and the share-cropper families the least. To illustrate with a single food, enough milk for home use was produced by two-thirds of the owner families, one-half of the share renters, and only one-third of the share croppers. The consumption of farm-grown vegetables and fruits, eggs, poultry and other meats, sirup, and corn meal was low in all groups. Among the factors considered responsible for this were low production, the use of home-produced foods for cash crops, and (as was the case in the South Carolina study) losses on storage of certain home-produced foods, notably sweetpotatoes. Increased emphasis on a home-production program with proper storage facilities is urged by the Mississippi station.

Food-consumption studies reported from Hawaii and Puerto Rico tell somewhat the same story of inadequacies of the diets in protective foods, even under conditions in which it would have been possible to provide a good diet through wiser buying or a greater effort at home production. Of particular interest in connection with the Social Security program is a study by the Hawaii station (in cooperation with the Department of Social Security of the Territory and with the assistance of the Work Projects Administration and National Youth Administration) of the food consumption of 38 Honolulu families who had been on relief for periods ranging from 2 months to 12 years. Analyses of food consumption records for a 4-week period showed that 58 percent of the diets were lacking in 7 or 8 essentials, 18 percent in 5 or 6, 13 percent in 3 or 4, and 10 percent lacking in 1 or 2 essentials. Some of the common errors in food buying were, making a poor selection of available fruits and vegetables, using too little milk or all fresh milk instead of part evaporated milk, buying too high-priced meats and too little of the organ meats, using too much of refined cereals and not enough of whole-grain products, buying staple foods in too small quantities, buying ready-prepared meats and vegetables, canned foods, and prepared breakfast cereals to avoid home cooking, and not using low-cost byproducts of such industries as rice milling. It is emphasized, however, that families cannot suddenly and drastically change their food habits but must be gradually educated and guided over a period of time toward different food habits.

In Puerto Rico a series of food supply and consumption studies by the University station has led to the conclusion that the greatest deficiencies in comparison with dietary standards (B.H.E.) are in the more expensive animal protein foods, notably eggs and dairy products, and that dietary improvement in Puerto Rico is principally dependent upon increases in income, particularly among the very poor. It is emphasized, however, that much might be done there by means of an educational program in nutrition, emphasizing (1) the need and desirability for vegetable gardens in rural areas, (2) the function and need of protective foods in the diet, and (3) the nutritional merits of locally grown starchy vegetables.

Dietary habits and nutritional status.—Extensive comparisons of dietary habits with nutritional status are being conducted by the Ellen H. Richards Institute at Pennsylvania State College. One of the completed studies involved over 400 school children in an industrial city of about 80,000 population where low incomes prevail. The dietary habits of the children were estimated in terms of weekly intakes of the principal food groups from records kept by some adult in the family for each child during a typical 3-meal day and from similar records kept by the children themselves for two days. The nutritional status of each child was evaluated from the 9 tests considered by the Pennsylvania investigators as the most practical for studies of this type. The records were sorted into 5 economic groups from families with an income of $5,000 and above to those on direct Government relief. Similarly, the responses to the various tests were sorted into 5 groups from those representing optimal conditions to the opposite extreme. Only 3 percent of the children fell in the two highest-income groups, 47.4 percent in the third, and 49.6 percent in the two lowest groups. With decreasing income there was a decrease in the average consumption of milk, meat, eggs, citrus fruits, and green vegetables; little or no difference between the middle and the two lowest groups in the consumption of yellow vegetables, tomatoes, and bread; and a higher consumption of fruits other than citrus in the middle than in the other groups. The nutritional-status tests showing the most consistent relationship to income were the hemoglobin content of the blood (which may have reflected the decreased amount of meat, eggs, and green vegetables with the lower family incomes); the skeletal status (probably attributable to the lower consumption of milk); and the dark-adaptation test as a measure of vitamin A (milk, eggs, and green vegetables). As judged by the physical examination given by physicians, the children in the two highest income groups ranked higher than those in the other groups, but there were no significant differences between the middle and lowest groups.

In contrast with this study of urban children was one recently completed by the Maine station in which nearly 700 grade-school children in three small towns in sections of the State where potato growing, fishing, and general farming, respectively, were the principal sources of income were examined in the fall and the following spring. In one community the study was repeated after a year's interval in which some educational work in health and in home gardens had been carried on. The nutritional-status tests included physical examinations (by physicians), dental examinations (by a dentist or director of dental hygiene), and a large number of physical measurements and tests for vitamin C and A deficiencies (by the experiment station research worker). Information on the diets was obtained for the most part through home visits. Bone defects were common in all three groups, and very few children were found with no dental caries, fillings, or extractions. In fact the most outstanding nutrition and health problem was considered to be the need for improving the condition of the bones and teeth by providing more calcium and vitamin D. Another important problem appeared to be the need for more vitamin C, as judged chiefly by the extent of inflamed gums. Anemia was also quite common during the winter months. At the time of the home visits the diets of the children were, on the average, low in milk, fruits and succulent vegetables, eggs, and whole-grain products.

The question which arose in this Maine study as to the need for more vitamin C in the diets of the children was answered in a special study conducted in a single school in a community in the potato-growing section of the State by the United States Children's Bureau in cooperation with the dental division of the State Board of Health, with some assistance from the experiment station. Blood-plasma ascorbic acid tests were made by the Children's Bureau investigator on a group of 86 children from 7 to 16 years of age, with saturation tests for a smaller number. The condition of the gums was observed, and some of the children showing inflammation were given ascorbic acid treatment. Dietary records were kept for a week in the fall and the spring by most of the children. An experiment station worker obtained information from the mothers as to the customary methods of cooking foods which were the chief sources of vitamin C in the diet, and analyzed samples of the foods cooked in the manner described. Evidence of vitamin C undernutrition in nearly all of the children was obtained in the low plasma ascorbic acid values; in the condition of the gums, which were inflamed in 29 percent of the children in the fall and in 51 percent in the spring; and in the improvement in the gums evident in about two-thirds of the children given vitamin C therapy.

Over two-thirds of the children were eating potatoes about once a day, cooked in most cases by methods that would result in considerable losses of vitamin C. From these cooking losses and the losses known to take place in potatoes in storage it was estimated that the amount of vitamin C furnished by the potatoes was about 15 milligrams daily in the fall and 8 milligrams in the spring. Cabbage, a practical source of vitamin C if eaten raw or cooked for a very short time, was eaten by only about one-fourth of the children in the fall and one-fifth in the spring. As it was generally cooked for from 30 minutes to even as long as 2 hours, with resulting vitamin C losses of from 46 to 67 percent, the children obtained very little vitamin C from this source. Rutabagas, the vitamin C content of nine common varieties of which ranged from 44 to 61 milligrams per 100 grams, lost from 14 to 50 percent of vitamin C in cooking. Even at that they would have been a very good source of the vitamin, but only about one-fourth of the children in the fall and one-sixth in the spring reported eating this common, readily grown vegetable. Another vegetable used was wild greens, but these were home-canned or home-salted and furnished very little vitamin C. Tomatoes were eaten to a limited extent by all the children and apples by about half of them. Taking everything into consideration, the diets were considered to be markedly inadequate in vitamin C in 40 percent of the cases in the fall and 52 percent in the spring. This study affords a striking demonstration of the relation of inadequacy in a particular food constituent to poor nutritional status, and also of the possibility of improving the diet through greater use of available foods and methods of preparing them so as to preserve their original food value to the fullest possible extent.

The school lunch.—The number of undernourished children receiving school lunches increased during the 1939–40 school year from 800,000 to 3,000,000 and in 1940–41 to 5,000,000, attending 57,000 or more schools in all of the States, the District of Columbia, and the Hawaiian Islands. Perhaps the greatest impetus to expansion of the school-lunch program has come through the action of the Surplus Marketing Administration of the Department in making surplus farm commodities available for free-lunch distribution in thosuands of schools throughout the United States through locally sponsored school-lunch programs.

The widely different conditions under which school-lunch programs operate in rural and urban communities are illustrated by the types of schools in which two of the experiment stations, South Carolina and Pennsylvania, have been carrying on research in connection with the school-lunch program. In South Carolina two similar rural schools were selected, in one of which a W. P. A. school-lunch project had been operating for several years while in the other no lunch was being served. In the first school, surplus commodities from the S. M. A. were used throughout the period, and the W. P. A. school-garden and canning project supplied sweetpotatoes, sorghum sirup, canned vegetables, and a turnip patch that yielded greens throughout most of the winter. There was even a school pig that had been fed in part on scraps from the school lunch and when slaughtered in December furnished meat and lard during the winter. In addition, milk, butter, eggs, vegetables, citrus fruit, and tomatoes were provided by the station. With these foods available it was possible to plan lunches providing on the average half or more of the day's requirement for minerals and vitamins and over one-third of the protein and calories. The children in both schools were given physical and medical examinations and tests for hemoglobin and blood levels of vitamins A and C at the beginning of school in the fall and at its close in April. Preliminary data indicated that at the beginning of the study the hemoglobin and ascorbic acid levels of the blood were in many cases below normal averages, while the carotene and vitamin A levels were in the range of normal (probably owing in large part to relatively large consumption of sweetpotatoes at that season). At the end of the school year the blood levels of both vitamins A and C tended to be higher in the school receiving the complete lunch than in the other school.

Following actual participation in the school-lunch program the South Carolina research station workers raised such questions as:

> Was the lunch served at the hour most likely to promote an adequate total food intake during the day? . . . Would a lunch served at the 10:30 morning recess or before fit better with the child's schedule than one served at noon? If his school lunch were served before noon would he not have an improved appetite for the food ordinarily saved for him from the family dinner? Since many rural schools would not have workers enough to bake bread and prepare a full noon meal, would it not be advisable to work out lunches suitable for serving at an hour early enough to supplement the breakfast, but not to take the place of the dinner at home? . . . In view of the general food habits in a community and the probable deficiencies in the poorer homes, what foods are especially needed to supplement the above dietary?

The last of the above questions received special attention in the study by the Pennsylvania station of the school lunch as a supplement to the home diet. For this study more than 200 grade-school children, selected from two nonmetropolitan cities, were given various nutritional tests, and careful records were made in the homes of the food eaten by the individual children during the week of the study. Comparisons were then made of the quantities of food essentials as calculated from the dietary records, the nutritional status, and the economic status of the children. With decreasing family cash income, the intakes of calcium and vitamin A fell rapidly, and those of protein, iron, vitamin B_1, and riboflavin more gradually from the highest- to the lowest-income group. The results of the general physical examination were also less and less satisfactory as the family cash income decreased. The responses to the various nutritional tests were consistent with the dietary records. The most marked differences as income decreased were found in less satisfactory skeletal mineralization and dark adaptation (evidence of decreases in calcium and vitamin A intake, respectively).

At the time of the study these city children had their midday meal as well as the morning and evening meals at home. With the thought that the deficiencies in their diet might most easily be made up by a midday meal at school, the Pennsylvania investigators determined from the food-consumption data the average quantities of the various food essentials consumed at breakfast and dinner by the children in each of the five income groups represented, and then calculated what would have to be provided in the school lunch to make up the day's requirements. For the two lowest-income groups combined, the ideal lunch to supplement adequately the average morning and night meals was estimated to require 1,660 calories of energy, 34 grams of protein, 0.45 gram of calcium, 0.70 gram of phosphorus, 0.082 gram of iron, 2,592 International Units of vitamin A, 271 International Units of vitamin B_1, 22 milligrams of vitamin C, and 1.39 milligrams of riboflavin per unit person. In comparison with the daily requirements per unit person of these items according to the Bureau of Home Economics standards, these figures mean that for these low-income groups the school lunch would have to furnish about two-thirds of the day's requirement of calcium and of riboflavin; a little over one-half of the calories, phosphorus, vitamin B_1, and iron; half of the protein; a little less than half of the vitamin A; and about one-fourth of the vitamin C.

The Pennsylvania workers are of the opinion that, if it were feasible to do so, a midday meal supplying the nutrients most likely to be lacking in the home meals should be provided at school to all children shown by objective nutritional tests to be in need of such supplements. In the absence of such tests and of information on the economic status of the individual children, and with the difficulties involved in making any discrimination among the children in a given school system, the plan considered most desirable is to feed all the children the ideal lunch for the lowest income group. In the Pennsylvania urban situation studied this would mean stressing foods valuable for protein, calcium, phosphorus, iron, and the various vitamins rather than calories.

TEXTILES AND CLOTHING

Fabrics and fibers.—When fabrics were of standard construction and made only of the natural fibers, selection of clothing fabrics involved only the relatively simple decision as to whether one wanted cotton, linen, silk, or wool. Nowadays, with many synthetic fibers, many yarns made of a single fiber or a combination of fibers, and many weaves, selection is far more difficult. With priorities on certain of the fibers, the manufacture of mixed fibers and mixed weaves will likely increase.

At a number of the experiment stations studies have been undertaken to determine the serviceability of various types of fabrics. In one of these studies, reported by the Kansas station, laboratory tests were made on all-silk, all-rayon, and silk-and-rayon-mixed fabrics for dresses and slips. These tests indicated that silk fabrics would probably withstand the wear and tear of use better than rayon fabrics, and that rayon would be more serviceable than the mixed fabrics. Successive dry cleanings increased shrinkage significantly, but after the first laundering there was practically no further shrinkage. Both in dry cleaning and in laundering the rayon fabrics shrank more than the silk or mixed fabrics. Silk dress crepes were much more crease-resistant than rayon crepes.

An extensive project, not yet completed, involves the cooperation of a number of the northeastern stations in determining the performance during wear of women's and children's wearing-apparel fabrics of different types. Laboratory tests on the worn garments are being correlated with observations as to wearing qualities in order to determine the causes of nondurability and to formulate fabric standards. In the course of this study it became necessary to develop a method for identifying the recently developed Nylon and Lanital (casein-wool) textile fibers so that these could be detected in the fabric samples. The Pennsylvania station made a study of the response of these fibers to microscopic and chemical tests frequently used in the identification of unknown textile fibers. On the basis of the response to these tests a scheme of identification was devised to differentiate Nylon and Lanital from each other and from other well-known fibers.

A recent report of a study by the South Dakota station of four wool fabrics composed of different percentages of virgin and reworked wool summarizes the findings concerning the fabrics as woven and after 15, 30, and 45 dry cleanings. Blending new and reprocessed wool of the types employed in varying proportions and subjecting them to the same manufacturing processes resulted in fabrics of different strength and elongation, and measurements of strength showed that these differences persisted throughout subsequent dry-cleaning and pressing processes. As the percentages of reprocessed wool increased, the fabric strength and elongation decreased. Dry cleaning and pressing the fabrics affected the strength and elongation in some instances and not in others, regardless of the blend.

THE HOUSE: CONSTRUCTION, CARE, AND EQUIPMENT

Thrift should be the watchword at this time in all items having to do with the house, from its construction to the smallest piece of equipment connected with its upkeep and management. Priorities on an ever-increasing number of materials formerly considered essential in household equipment necessitate substituting less familiar materials or learning to go without. Priorities on aluminum have already been felt in the kitchen, where aluminum cooking utensils have been in common use. Possible curtailment in electric power calls for more careful use of electrical equipment, with adjustments to prevent waste, or even a change to other sources of heat and energy. More adjustments are to be expected, and the homemaker must be ready for them.

Economies in production and performance of essential household equipment are being sought by the Office of Price Administration and Civilian Supply through requests to the American Standards Association for standardization work on various pieces of equipment. At the time of writing, requests have been received for such work on mechanical refrigerators, washing machines, and electric flatirons. The equipment research of the various experiment stations should furnish useful information for the standardization program on certain types of equipment. The work of the Virginia station on electric irons, which has been continued as new models have appeared on the market, illustrates the practical value of experiment station research in this field. Similarly, the work of the Nebraska station on electric, gas, and gasoline ranges should prove useful as the standardization program expands.

Low-cost rural housing.—A visitor at the Arkansas station will find on the campus a four-room modern frame house with bath, closets, and screened work porch built for the purpose of demonstrating savings that can be effected, using unskilled labor and lower-quality materials. Almost half of the hours of labor required were supplied by common unskilled labor. The total cost of the house, which has an area of 768 square feet and a volume of 10,000 cubic feet, was $1,400. About $70 was saved through the use of rough lumber, and another $25 from the use of local masonry material. Wood ceilings, shower bath instead of tub, homemade doors and screens, and low-cost hardware contributed to the savings, which came to a total of approximately $400.

At the Oregon station the visitor interested in rural homes would find a set of miniature scale models constructed from plans developed at the station by carpenter labor furnished by W. P. A. These models illustrate in detail many of the elements found desirable for minimal farmhouse planning design and construction. The terms “minimal” and “low cost” are given to the lowest recommended and adequate permanent house as determined from construction-cost data on rural and suburban dwellings in a number of counties in the State. The minimal farmhouse is built on piers and in most instances has standard walls and bearing partitions. Seventeen variations of minimal farmhouse plans, all of which include a plot plan showing the recommended orientation of the house in the farmstead group, have been completed and are available for distribution in blueprint form. For the permanent low-cost farm home, most of the plans include a basement, for it has been found that on farms where cellars can be easily dug and adequately drained, where the basement can be used for the storage of fuel and food, and where a central heating plant, laundry, drying, and other service functions are required, it is cheaper to build with a basement than without. In practically all of the cases studied the owners did the excavating in slack seasons and thus reduced the costs.

The long-time research program of the Oregon station on the standardization of space utilization and the arrangement of areas in the house is bearing fruit in this farm-home construction program. During the year two series of house plans for the average farm owner of the State were completed: a one-story four-room, and a one-and-one-half-story five-room farmhouse, both with basements. The floor plans in each series have been rated as to use of space factors, and composite ratings of floor plans with cost-of-construction ratings have been established. From the plans rating high in utility and low in estimated cost, selections may be made to suit specific conditions of orientation and direction of farm buildings from the house. Working drawings of these plans will show the best location of essential furniture and equipment and thus will make it possible to visualize the interior of the home when furnished and equipped.

Floor finishes.—The treatment of floors is an important item in both old and new houses as regards initial cost and upkeep, ease of routine care, and appearance. Where initial expense permits, hardwood floors are usually the choice for most of the rooms, with linoleum or some type of easily cleaned all-over covering for the kitchen. According to practical and laboratory studies at the Rhode Island station, the penetrating-seal finish, if properly maintained, is the most satisfactory for hardwood floors. This non-film-forming finish has the advantage over other types of finish in that worn places in high-traffic areas or places where something has been spilled may be repaired very easily without leaving a patched appearance. However, the Rhode Island workers caution against applying a penetrating-seal finish directly over another finish. The old finish should first be completely removed, either by sanding or scraping down to new wood. Floors of soft wood, such as pine, tend to soil badly when finished with a penetrating seal, unless extraordinary care is taken to protect the surface with a good wax film, frequently renewed.

The slipperiness of a floor finish is an important factor to consider. To measure this hazard in the home, the Rhode Island station is adding an apparatus for testing slipperiness to the station equipment for testing various factors in floor finishes.

Felt-base floor coverings continue to receive attention by the New York (Cornell) station as being the floor covering most commonly used in home kitchens in the State. Long-time tests of various finishes under actual home conditions have led to the conclusion that varnish delays wear longer than wax or lacquer but tends to wear off in spots which cannot be refinished smoothly. Since many homemakers have the idea that waxing felt-base floor coverings tends to make them slippery, the station has devoted considerable attention to devising and applying a mechanical friction test in which a weighted piece of new smooth shoe leather is tested against felt-base coverings, both new and old, treated with different types of wax. Instead of being more slippery the waxed coverings appear to be less slippery.

Pressure gasoline and kerosene stoves.—In studies practically completed at the Nebraska station it was shown that pressure gasoline and kerosene stoves are capable of giving a much higher performance than stoves using ordinary gravity feed of fuel. Of four stoves of this type tested, one stood out as superior to the others in a number of respects, particularly safety from the hazard of carbon monoxide production and explosions. The Nebraska workers are of the opinion that the better stoves of this type are very convenient and useful where electricity or gas is not obtainable, provided the users remember that they are handling an explosive fuel.

Electric ranges.—Homemakers confronted with the responsibility of learning how to use an electric range most economically will find very helpful a recent bulletin of the Maine Extension Service, portions of which are based on research conducted at the station. This publication gives estimates of the cost of owning an electric range, including purchase price, cost of installation, probable life and repairs, probable kilowatt consumption per month, and cost of operation; points to consider in the selection of a range, including characteristics of models at various prices, differences in cost of using various makes, differences in performance of various ovens, and other miscellaneous features; and suggestions for the economical management of top-stove units and of the oven.

Frequently adjustments are necessary in electric or other ranges after their installation. If the thermostat controlling oven temperature is not set correctly, unsatisfactory results are obtained in baking when temperature directions are followed. How much error there can be in a thermostat setting without affecting the quality of the baked products was tested at the Virginia station. Biscuits were found to bake best at a temperature of 425° F., but to be quite acceptable within a range of 25° on either side, that is, from 400° to 450°. Similarly, loaves of bread baked best at 400°, pie shells at 425°, and butter cake at 350°, with a range of 25° on either side. Angel-food cake baked best at 325° but with a range of only 12½° on either side. Tests of thermostats on range ovens of early and late models showed that few of the early models had sensitive enough thermostat control to come within these temperature variations, but that the more recent models easily met the requirements and often maintained temperatures within 10° F. of the thermostat setting. Consequently, if a new range gives unsatisfactory results in baking the different products at the temperatures noted above, it would be well to report the difficulty to the service man.

Uneven browning and baking of products may mean poor heat distribution in the oven, or more likely, in the newer ovens at least, an interference with the heat distribution (a baffling effect) by the baking pan itself. This is particularly true of solid baking sheets for cookies. The Virginia station found that a baking sheet of one-fourth inch mesh wire cloth gave more even browning than the solid baking sheet. This suggests an inexpensive substitute for an aluminum baking sheet.

In the interest of economy in the use of an electric range the housewife may load her oven to the point at which batters and doughs do not brown satisfactorily and certain types of batters may rise to a peak and split. In studies at the Maine station the failure of batters to brown on top when baked in a loaded oven was traced not, as commonly believed, to the steam escaping from the watery foods but to insufficient heat reaching the food in the loaded oven, either from inadequate circulation of ample heat or from the insufficient heat capacity of the oven. The rising to a peak and splitting of batter depends upon the richness or leanness of the batter. Rich batters like butter cake, refrigerator cookies, and pie crust are not affected by the steam while muffins and less rich cake batters are. Custards bake more quickly in a steam-filled oven. A few trials with different foods will show what combinations can be baked most satisfactorily at the same time with resulting saving in electricity.

Home refrigerators for frozen storage.—The advent of frozen-locker storage for farm-produced food for home use has increased rather than decreased the need for better refrigeration facilities in the farm home. for community lockers are often located at too great a distance from the home to warrant daily trips to remove foods for immediate use only. Moreover, improvements and reduction in cost of freezing units have now brought down the cost of large farm-refrigerator units to more reasonable figures, and more farm families are becoming interested in having their own freezing units. Studies have been made by the Indiana station on energy consumption, temperatures maintained, and foods stored by individual families in 2 commercial units of 14- and 30-cubic-foot capacity and one home-built unit of 70 cubic feet. These units gave average energy-consumption figures of 50, 145, and 217 kilowatt-hours per month, respectively. The families using these units were well satisfied with this method of food preservation, but the station workers feel that there is a definite need for a less expensive unit or for the design of a freezing unit simple enough to be constructed on the farm.

FAMILY ECONOMICS

Wise management of family resources is called for in any home program for maintaining good health and good living conditions. Data showing how much families have received in net cash receipts, what they have had by way of noncash resources, and how they have used this income for family living can serve as a measuring stick for families wishing to make the best use of their resources. A number of the experiment stations have studied the records of many farm families and have summarized their findings to show what these families have been able to obtain in family living with their various incomes.

Family incomes and expenditures.—From an analysis of 293 records of farm-family expenditures available for a 19-year period from 1922 to 1940, the Colorado station found that cash expenditures ranged from $849 in a lean year (1932) to $1,885 in more prosperous times (1927); and that total expenditures ranged from an average of $1,319 in 1932 to $2,657 in 1927, with an average for the whole period of $2,057 per family, or $451 per capita. This total of $2,057 included an average of $1,460 for personal and household expenses (including $322 for automobile, electricity, telephone, and cash repairs on the dwelling), $317 for depreciation and interest on dwelling and depreciation on automobile, and $280 for family living. The value of home-raised foods was only $176 in 1933 but amounted to $394 in 1924. These records of families of different size and of farm operators making a comfortable living are considered representative and suitable as a goal for satisfactory farm life under conditions similar to those in the northern Colorado irrigated area where this study was made.

Records of 188 Iowa farm families reporting in 1939 showed that the total cash spent for living averaged $1,171, and that home-produced foods amounted, in addition, to $249. The records, further analyzed by the Iowa station, showed that families having children under 7 years of age and incomes under $1,500 had a net loss for the year, while families in the group with incomes above $3,000 had an average net saving of $4,000. Through the supervision of the Farm Security Administration it was possible to observe home management practices in one of the counties involved in this study. It was found that home-produced food represented slightly more than half the total value of living, and that families on high-profit farms used somewhat more farm-produced foods than families on the low-profit farms. The use of all home-produced foods except milk and potatoes was short of the amounts set down in the plans. Progress in line with the supervisor's recommendations was made in the use of pressure cookers in canning, in the reduction of food spoilage in canned goods, and in the quantity of dried vegetables stored. The greatest difference in the expenditures of families on high- and low-profit farms was for the automobile, education, recreation, and health. Total cash living expenses averaged $72 less than budget estimates for the year.

A report from the Illinois station showed that in 1940 the money value of living of the 493 farm and small-town families presenting complete records was less than $1,000 for 7 percent of them, amounted to $1,000 to $2,000 for 57 percent, and was over $2,000 for 36 percent. This included the value of the various foods produced for family consumption. Of interest from the standpoint of the food-for-freedom program is the fact that 5 percent of these families produced less than 35 percent of their food, 47 percent produced between 35 and 55 percent, 40 percent produced between 55 and 75 percent, and 8 percent produced over 75 percent of their food. Ninety-two of the farm families had kept home-account records continuously for 5 years (1936–40), and 30 had kept such records continuously for as long as 10 years (1930–40). Analyses of these continuous records showed the sort of changes made by farm families in adjustment to their problems in years of increased income and again in years of decreased income. When income increased, farm-mortgage payments increased more rapidly than any other item in the budget, indicating that land ownership was one of the outstanding goals of these farm families. The records showed further that wise use of credit, management of noncash resources (farm-furnished food and housing), and landlord-tenant relationships had a direct bearing upon the level of living of the family.

Price variations of commodities.—Information concerning the possibilities of saving money in household buying of food and supplies by wise choice of stores and timing of purchases was obtained in studies by two stations. Regular and sale prices for 23 common grocery-store commodities as sold in 42 retail grocery stores in Burlington, Vt., were obtained by the Vermont station. Prices were found to be somewhat higher in outlying stores than in secondary stores and higher in the latter than in downtown stores. Prices quoted by large chain stores averaged 12 percent lower than those quoted by the independents, while the voluntary chains averaged only a 1-percent reduction as compared with the independents. Credit and delivery services apparently tended to increase prices. Twice as many items were found on special sale on Saturdays as on other days, and there were a few more sale offerings on Thursdays than on Tuesdays. Most sale offers were for single commodities and only a very few were combination offers. Two-thirds of all sale prices were reduced from regular ones, the savings averaging 10 percent for all sale offers and 14 percent on those which were actual reductions. The commodity classes on which sale offers were most frequently made were soaps, canned vegetables, household supplies, canned fruits, coffee and tea, relishes, prepared dishes, dessert materials, and fats.

Preliminary reports on another study of the services, type of operation, prices, etc., of 4 shopping areas serving farm homes in Vermont showed chains underselling independents by 10 percent. From the data gathered it appeared that the farm families made rather good selection of stores and of amounts and package sizes of foods in their attempt to save money.

A number of national brands of commodities and foods more or less variable in quality were items included in a survey by the Iowa station of the prices charged by national chain and independent stores in 10 Iowa cities ranging in population from 10,000 to 60,000. This survey showed that there had been a marked development of "supermarkets" in small Iowa cities in recent years. In price comparisons it was found that for each of the 10 cities the average price for all items included was less in the national chains than in the independents. This was particularly true of grocery prices, although in certain instances prices for green groceries totaled less in the nonservice independent stores than in the competing chains. The difference between independent- and chain-store prices varied greatly from city to city, and in 4 of the 10 cities the lowest-priced independent store had prices lower than, or within 2 percent of the lowest-priced chain. Nearly all of the independents had a few items the prices of which were equal to or lower than those of the same items in the chains. Sheeting, one of the commodities investigated, was found in many of the towns to be of much the same quality in independent and chain stores, but to be cheaper in the latter. In 7 of the towns, however, the sheeting sold in the chain stores was higher in quality and higher in price than in the competing independent.

These several studies show that for wise family buying the shopper must know what she wishes in the way of quality in the goods she buys and must keep informed on the comparative offerings of the stores she patronizes.

FAMILY RELATIONSHIPS

In times of stress happy relationships within the family and the maintenance of a high morale among all its members are particularly important. To this end the research program in family relationships of the Nebraska station continues to make notable contributions. An investigation over a period of years of personality development in farm, small-town, and city children was completed, with the development of a so-called Parent Attitude Scale for use in home demonstration club work with rural parents. The scale contains 30 items, half of which reflect strict discipline and obedience and the other half freedom from parental control. After scoring their own views, individual parents have the opportunity of comparing their views with those of a group of child-development specialists, psychologists, and other authorities in the field of family relationships, most of whom were also parents.

When the scale was tested on the parents of the high-school students who had served as subjects in the personality-development study and their scores compared with the opinions of the "experts," it was found that strict discipline and obedience were favored by the majority of the parents, while freedom from parental control was favored by the experts in checking many of the items on the score card. However, the statements on the scale suggesting complete relinquishment of parental control were not favored by the experts but rather parental control through cooperation and guidance. It is of significance that the children of the Nebraska parents whose attitude scores most nearly approached the average scores of the specialists in the field of family relationships were more self-reliant in meeting ordinary personal difficulties than were the children of parents scoring on the other side.

The development of a sense of responsibility and self-reliance in young people was never more urgently needed than at the present time. The Nebraska station is extending this type of investigation to the measurement of "morale" and the conditions relating to good or poor morale.

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